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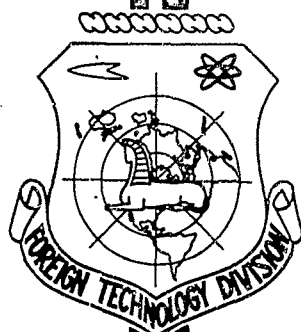
# TRANSLATION

THE BURNING OF AMMONIUM PERCHLORATE

By

L. D. Romodanova and V. I. Roshchupkin

## FOREIGN TECHNOLOGY DIVISION



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## THE BURNING OF AMMONIUM PERCHLORATE

L. D. Romodanova and V. I. Roshchupkin

Thermal decomposition of ammonium perchlorate has been discussed in a number of works [1, 2; 3, 4]. We carried out thermal decomposition of ammonium perchlorate at  $p \sim 2$  to 4 mm Hg and burned it under pressure up to 150 kg/cm<sup>2</sup>. When heated under vacuum ( $p \sim 2$  to 4 mm Hg) ammonium perchlorate is partially sublimated at  $\sim 200$  to 210°, and partially decomposed to gaseous products without selfignition (endothermic process). When heated for 30 to 40 min, 80 cm<sup>3</sup>/g gaseous products of thermal decomposition are formed (28 to 30% of the ammonium perchlorate is decomposed), consisting of NO, NO<sub>2</sub>, N<sub>2</sub>, N<sub>2</sub>O, Cl<sub>2</sub>, HCl, HClO<sub>4</sub>, O<sub>2</sub> and H<sub>2</sub>O. Additionally, NOCl is formed at 300°. The experiments under pressure were performed in a bomb. The pressure in the bomb was created by nitrogen. The burning rate of ammonium perchlorate was measured optically by a photorecorder. We studied the effect on the burning rate, at various pressures, of the density of a pressed sample of NH<sub>4</sub>ClO<sub>4</sub>, of the size of the particles of the powder, and of moisture. To study the effect of moisture on the burning of ammonium perchlorate, a dry powder of NH<sub>4</sub>ClO<sub>4</sub> was moistened with water vapor, which was poured into a

desiccator, where the salt was stored, and from the moist salt, samples were pressed having a density of 1.92 to 1.93 g/cm<sup>3</sup>. It was found that at a water content from 0.1 to 0.7%, the lower pressure limit for stable burning did not vary. At a moisture content above 2%, the sample did not burn at all over the pressure range studied by us (up to 150 kg/cm<sup>2</sup>).

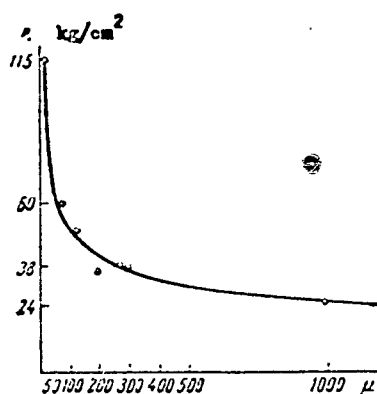


Fig. 1. Limiting pressure for stable burning versus particle size.

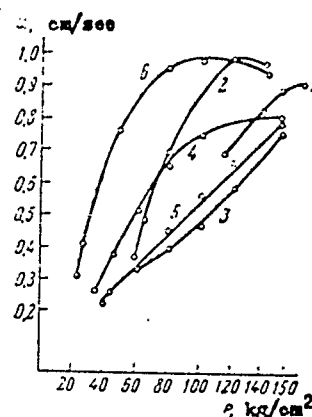


Fig. 2. Burning rate versus pressure: 1) 3 to 7μ; 2) 55 to 95μ; 3) 5 to 250μ; 4) 100 to 300μ; 5) 250 to 400μ; 6) 300 to 3000μ.

The pressure limit for stable burning decreases with an increase in the density of the samples. For a cut of 200 to 350μ at a density  $\rho = 1.51$  g/cm<sup>3</sup>, the lower limit is 53 kg/cm<sup>2</sup>; for  $\rho = 1.67$  g/cm<sup>3</sup>, 48 kg/cm<sup>2</sup>; and for  $\rho = 1.92$  g/cm<sup>3</sup>, 38 kg/cm<sup>2</sup>. The limiting pressure for stable burning decreases with an increase in the diameter of the sample: for a diameter of 8 mm, the limiting pressure is 38 kg/cm<sup>2</sup>; for 12.7 mm, 33 kg/cm<sup>2</sup> (the density of the samples was 1.92 g/cm<sup>3</sup>, the particle size 200 to 350μ).

The following samples were used to study the effect of the size

of ammonium perchlorate particles upon the lower pressure limit and the burning rate.

1. A coarse crystalline salt of  $\text{NH}_4\text{ClO}_4$  obtained by recrystallization of ordinary ammonium perchlorate from an aqueous solution of alcohol and dried to constant weight at 65 to 70° (300 to 3000 $\mu$ );

2. Ordinary (undiffused) ammonium perchlorate with a particle size of 100 to 2500 $\mu$ ;

3. Cuts of 250 to 400 $\mu$ , 200 to 350 $\mu$  (from ordinary commercial ammonium perchlorate); 55 to 95 $\mu$  (from ammonium perchlorate obtained by rapid crystallization from alcohol); 10 to 250 $\mu$ , and 3 to 7 $\mu$  (obtained from the ordinary salt, ground on a vibrating mill; the ammonium perchlorate was charged with 0.1 to 0.2%  $\text{Fe}_2\text{O}_3$ ).

As our specially set-up experiments showed, this amount of  $\text{Fe}_2\text{O}_3$  did not affect the burning of ammonium perchlorate.

The results of experiments on the effect of the size of the ammonium perchlorate particles upon the limit of stable burning are given in Fig. 1.

The dependence of the lower limit of pressure for the burning of ammonium perchlorate upon the particle size is explained as follows. Heat (from the filament) is apparently better transmitted to the depths of a sample by a large crystal, the size of which is on the order of several hundreds of microns. In the case of coarse grain, the chance of penetration by hot gases into the pores is probably greater than in the case of a fine grain. Therefore, in the case of coarse crystals of ammonium perchlorate, stable burning is observed at  $p \sim 25 \text{ kg/cm}^2$ , and in the case of fine crystals, only at 115 to 118  $\text{kg/cm}^2$ , i.e., high pressure is necessary in order to maintain the basic reaction determining burning.

As is apparent from Fig. 2, the dependence of the burning rate of ammonium perchlorate upon pressure is not the same for powders with various particle sizes.

### Conclusions

1. The limiting pressure at which a sample burns stably at a constant density of the sample is greater, the smaller the particle size.
2. With an increase in the density of the sample, the limiting pressure decreases.
3. A moisture content in tablets of ammonium perchlorate of up to  $\sim 0.7\%$  does not substantially affect the limiting pressure.
4. The burning rate of ammonium perchlorate at a pressure of  $\sim 150 \text{ kg/cm}^2$  for all the cuts studied by us approached a constant value.

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Submitted October 30, 1961.

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